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$$-\frac{24ar^2(a-r)}{3be^4}(1+e^2)-\frac{2ar(4R^2-3b^2)}{be^2}-\frac{4R^3r^2}{bcde^2}-\frac{4R^3r^2}{bc_1he^2}\Bigg]E(e,\ \tfrac{1}{2}\pi)$$

$$+\ \tfrac{4}{3}\Bigg[-\frac{8br^2}{15e^4}(2-3e^2+e^4)+\frac{4abr}{e^2}(1-e^2)+\frac{8ar^3}{15be^6}(8+3e^2+4e^4)$$

$$+\frac{12ar^2(a-r)}{3be^4}(2+e^2)+\frac{2ar(4R^2-3b^2)}{be^2}$$

$$-\frac{(a-r)(ab^2+2R^2r)}{b}-\frac{4R^3r^2}{bc^2de^2}(ce^2+e^2-c)-$$

$$\frac{4R^3r^2}{bc_1^2he^2}(c_1e^2+e^2-c_1)\Bigg]F(e,\ \tfrac{1}{2}\pi)+\frac{16R^3r^2}{3b}\left[\frac{c+1}{dc^2}\Pi(e,\ c,\ \tfrac{1}{2}\pi)+\frac{c_1+1}{hc_1^2}\Pi(e,c_1,\tfrac{1}{2}\pi)\right]$$

$\therefore\ V=AE(e,\ \tfrac{1}{2}\pi)+BF(e,\ \tfrac{1}{2}\pi)+C\Pi(e,\ c,\ \tfrac{1}{2}\pi)+C_1\Pi(e,\ c_1,\ \tfrac{1}{2}\pi)$, suppose.

Let $\dfrac{a^2+R^2-r^2}{2a}=x_1$; then from $a=R-r$ to $a=R+r$,

$$V_1=4\int_{x_1}^{R}\int_0^{\sqrt{(R^2-x^2)}}\sqrt{[R^2-x^2-y^2]}dxdy+4\int_{a-r}^{x_1}\int_0^m\sqrt{[R^2-x^2-y^2]}dxdy$$

$$=\pi\int_{x_1}^{R}\sqrt{[R^2-x^2]}dx+2\int_{a-r}^{x_1}mndx+2\int_{a-r}^{x_1}(R^2-x^2)\sin^{-1}\left(\frac{m}{\sqrt{[R^2-x^2]}}\right)dx.$$

$$\therefore V_1=\tfrac{1}{3}\pi[2R^3-(a-r)(2R^2+b^2)]+AE_0^{\theta_1}(e,\ \theta)+BF_0^{\theta_1}(e,\ \theta)+C\Pi_0^{\theta_1}(e,\ c,\ \theta)$$

$$+C_1\Pi_0^{\theta_1}(e,c_1,\theta),\text{ where }\theta_1=\tfrac{1}{2}\cos^{-1}\left(\frac{a^2+r^2-R^2}{2a}\right).$$

$$\therefore\triangle=\frac{\int_0^{R-r}Vda+\int_{R-r}^{R+r}V_1da}{\int_0^{R+r}da}.$$

A partial solution was given by *J. M. COLAW.*

MISCELLANEOUS.

83. Proposed by ALOIS F. KOVARIK, Instructor in Mathematics and Physics, Decorah Institute, Decorah, Iowa.

Segment's area of a circle whose radius is 5 inches is 28.56 square inches. Find the chord.

Solution by **W.W. LANDIS, A.M.**, Professor of Mathematics and Astronomy, Dickinson College, Carlisle, Pa.; **H. C. WHITAKER, Ph. D.**, Professor of Mathematics, Manual Training School, Philadelphia, Pa.; **COOPER D. SCHMITT, A.M.**, Professor of Mathematics, University of Tennessee, Knoxville, Tenn.; **G. B. M. ZERR, A.M.,Ph.D.**, Professor of Mathematics and Science, Chester High School, Chester, Pa.; **J. SCHEFFER, A. M.**, Hagerstown, Md.

Let θ be the angle of the segment, c the chord.

$\therefore \frac{25}{2}(\theta-\sin\theta)=28.56$, $c=10\sin\frac{1}{2}\theta$.

But $\theta-\sin\theta=2.2848$.

$\therefore \theta=155^\circ\ 4'$ nearly. $\therefore c=9.764$ inches.

84. Proposed by **COOPER D. SCHMITT, A. M.**, Professor of Mathemalics. University of Tennessee, Knoxville, Tenn.

Prove that $e^\pi+e^{-\pi}=2[1+2^2][1+(\frac{2}{5})^2][1+(\frac{2}{5})^2]$. . .ad infinitum.

I. Solution by **J. W. YOUNG**, Fellow and Assistant in Mathematics, Ohio State University, Columbus, O.; **J. O. MAHONEY, M. Sc.**, Professor of Mathematics, Central High School, Dallas, Tex.; **HARRY S. VANDIVER**, Bala, Montgomery Co., Pa.; **M. E. GRABER**, Heidelberg University, Tiffin, O.; **ELMER SCHUYLER, B. Sc.**, Professor of Mathematics and German, Boys' High School, Reading, Pa.; **J. SCHEFFER, A. M.**, Hagerstown, Md.; **G. B. M. ZERR, A. M., Ph. D.**, Professor of Mathematics and Science, Chester High School, Chester, Pa.; and **PROPOSER.**

From trigonometry we have the formula :

$$\cos\theta=\left(1-\frac{4\theta^2}{\pi^2}\right)\left(1-\frac{4\theta^2}{3^2\pi^2}\right)\left(1-\frac{4\theta^2}{5^2\pi^2}\right)\left(1-\frac{4\theta^2}{7^2\pi^2}\right).\ .\ .\ .\ .$$

In this replace θ by θi and we have

$$\cosh\theta=\left(1+\frac{4\theta^2}{\pi^2}\right)\left(1+\frac{4\theta^2}{3^2\pi^2}\right)\left(1+\frac{4\theta^2}{5^2\pi^2}\right)\left(1+\frac{4\theta^2}{7^2\pi^2}\right).\ .\ .\ .\ .$$

Now let $\theta=\pi$, whence

$$\cosh\pi=(1+4)\left(1+\frac{4}{3^2}\right)\left(1+\frac{4}{5^2}\right)\left(1+\frac{4}{7^2}\right).\ .\ .\ .\ .$$

$$=[1+2^2][1+(\tfrac{2}{3})^2][1+(\tfrac{2}{5})^2][1+(\tfrac{2}{7})^2].$$

But $\cosh\pi=\frac{1}{2}[e^\pi+e^{-\pi}]$, whence the result.

II. Solution by **MISS MARY M. BLAINE, A.M.**, Teacher of Mathematics, High School, Springfield, Mo., and **MISS ALICE MADELEINE McKELDON**, Graduate Student, University of Pennsylvania, Philadelphia, Pa.

To prove that $e^\pi+e^{-\pi}=2[1+2^2][1+(\frac{2}{3})^2][1+(\frac{2}{5})^2]$. . . .

We have (1) $\cos x=1-\frac{x^2}{2\,!}+\frac{x^4}{4\,!}-\frac{x^6}{6\,!}+$. . .

(2) $$\cos x=\left(1-\frac{4x^2}{\pi^2}\right)\left(1-\frac{4x^2}{3^2\pi^2}\right)\left(1-\frac{4x^2}{5^2\pi^2}\right).\ .\ .\ .\ .$$

[See Chrystal, Vol. II, page 329.]

Expanding this infinite product, and collecting,